Spatial Data Transfer Standard (SDTS)
Part 5: Raster Profile with BIIF Extension

(Working DRAFT, Version 1.00)

Standards Working Group Base Cartographic Subcommittee
Federal Geographic Data Committee

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Federal Geographic Data Committee
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Department of housing and Urban Development• Department of Interior• Department of State
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Federal Geographic Data Committee

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SDTS PART 5: RASTER PROFILE WITH BIIF EXTENSION

1 Introduction

The Spatial Data Transfer Standard (SDTS) defines a general mechanism for the transfer of geographically referenced spatial data and its supporting metadata (i.e., attributes, data quality reports, coordinate reference systems, security information, etc.) The overriding principle that SDTS promotes is that the spatial data transfer should be self-contained. The dataset in SDTS should contain all of the information that is needed to assess and/or use the data for a particular GIS application. SDTS is most appropriate for blind transfers, spatial data archives, and data distribution in a non-proprietary format.

A SDTS profile, in general terms, may be defined as a limited subset of the standard, designed for use with a specific type of data (i.e., topological vector, point, gridded, image, etc.) Specific choices are made for encoding possibilities not addressed, left optional, or left with numerous choices within the SDTS base specification (consists of Parts 1, 2, and 3.) A SDTS profile shall provide for the transfer of files, records, fields and subfields with the following objectives:

a. to encode in a standard format;

b. to provide for machine and media independence;

c. to accompany the spatial data with their description;

d. to preserve all meaning and relationships of the data;

e. to keep both field and records to an appropriate maximum length; and,

f. to make use of other industry related standards.

The Basic Image Interchange Format (BIIF) defines a general mechanism for the transfer of image data and any supporting data (i.e. image parameters, visualization parameters, compression parameters, text annotations, symbols, etc.) BIIF is intended to be used to transfer any digital image---x-rays, fingerprints, portraits, aerial photography, remotely sensed data, etc. A BIIF profile is specified based on the requirements of a data producer/user community for a certain application domain. For example, there might be a law enforcement BIIF profile for fingerprints and mug shots; a medical BIIF profile for x-rays; a natural hazards management BIIF profile for forest fires, etc. The SDTS Raster Profile with BIIF Extension (SRPBE), a profile of SDTS, will be proposed as a geographic information BIIF profile for raster data, to further the convergence of raster standards. To this end, Annex A of this SRPBE is intended to be equivalent to the NITF profile of BIIF.

This document is organized into a main body, called the profile core specification, and a number of annexes, both informative and normative. SRPBE uses the same major headings found in SDTS Part 1. Specific discussions regarding encoding possibilities in SDTS Part 1 and BIIF are grouped under each major heading and will include specific references to BIIF and SDTS Parts 1, 2, or 3 where necessary. Annex A is the profile annex option which permits the BIIF to be used for the image data portion of an SDTS transfer. Annex B permits the SDTS color modules to be used. Annex C permits data compression to be used. Annex D permits special purpose transfer where it may be necessary to omit otherwise mandatory information. Annex E contains examples to help clarify the implementation of this profile. Annex F is a crosswalk between the standards terms and concepts to assist those familiar with just SDTS or just BIIF.

1.1 Objective

The SRPBE seeks to take advantage of the capabilities of both SDTS (raster portion) and BIIF. The SDTS has a geographic information focus and provides the capability of encoding raster grid and image data, georeferencing information, simple color look-up tables, data quality reports, data dictionary information and other such metadata. The BIIF has an image transmission focus and provides an efficient image file format, image compression, image blocking/tiling, variety of color models, and visualization controls. Rather than modify SDTS structures to directly include these more advanced image handling capabilities, this profile seeks to use BIIF structures as defined. This approach will alleviate redundant development of similar capabilities and facilitate convergence of the military and commercial spatial data communities. This approach is possible because the SDTS was designed with a separation of logical structures and format.

1.2 Scope

The SDTS Raster Profile with BIIF Extension (SRPBE), contains specifications for a profile for use with georeferenced two-dimensional raster data. Both raster image and raster grid data are included within the scope of this profile. The transfer of indirectly referenced images is permitted (i.e., a satellite image of St. Louis, MO where city and state are the only ground based reference included.) Excluded are greater than two-dimensional raster data and vector data.

SRPBE can accommodate image data, digital terrain data, gridded geographic information system (GIS) layers, remotely sensed images, and any other data that can be conceptualized as two-dimensional array of data values. For the purposes of SRPBE, both gridded data and image data will be referred to as raster data.

1.3 Applicability

SRPBE can be utilized by the Defense and Civil communities to accommodate exchange of image data, digital terrain data, gridded geographic information system (GIS) layers, remotely sensed images, and any other data that can be conceptualized as two-dimensional array of data values.

1.4 Related Standards Referenced

The following references contain provisions which, through specific references in this text constitute provisions of SRPBE. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on SRPBE should investigate any recent editions of the references listed below.

DMA Technical Manual 8358.1 Datums, Ellipsoids, Grids, and Grid Reference Systems, Edition 1, September 1990.

FGDC Content Standards for Digital Geospatial Metadata, June 1994.

FIPS PUB 173 - Spatial Data Transfer Standard (SDTS) . 28 August 1992.

ISO 8211 Data Descriptive File for Information Interchange, 1984.

ISO/IEC 8632-3:1994 Information technology - Computer graphics - Metafile for the storage and transfer of picture description information - Part 3: Binary encoding Amendment 1:1994 to ISO/IEC 8632-1:1992 Rules for profiles Amendment 2:1995 to ISO/IEC 8632-1:1992 Application structuring extensions.

ISO/IEC 12087-5 - Information Technology Computer Graphics and Image Processing, Image Processing and Interchange Functional Specification Part 5: Basic Image Interchange Format (BIIF). Draft International Standard, July 11, 1997.

JIEO/JITC Circular 9008 - National Imagery Transmission Format Standards (NITFS) Certification Test and Evaluation Program Plan, 30 June 1993.

MIL-STD 2500B National Imagery Transmission Format (NITF) Version 2.1, Draft 1997.

NITF Profile of BIIF; To be developed by the Format Working Group under the auspices of the NITF Technical Board; Not Yet Drafted; Scheduled to start in 1997.

STANAG 4545 NATO Secondary Imagery Format (NSIF), Ratification Draft 1, 15 April 1997.

STANAG 7074/AGeoP-3A Digital Geographic Information Exchange Standard (DIGEST), Edition 1.2a, June 1995.

1.5 Standards development procedures

The Spatial Data Transfer Standard (SDTS) Raster Profile with Basic Image Interchange Format (BIIF) Extension was developed jointly by the U.S. Geological Survey (USGS) and the National Imagery and Mapping Agency (NIMA). The SDTS Raster Profile with BIIF Extension (SRPBE) was developed as an interface and intermediary step to the convergence of the SDTS raster capabilities and the BIIF raster transmission standards. The SRPBE

provides a means of using the archival capabilities, the non-proprietary distribution mechanism, and the geographic information focus of the SDTS and the imagery transmission focus of BIIF.

BIIF was developed from a complement of military, ANSI, ISO, and NATO standards which were derived from the U.S. Military Standard 2500 National Imagery Transmission Format Standard (NITFS) and JIEO/JITC Circular 9008. The NITFS is a format initially developed for the transmission of military intelligence and digital mapping, charting and geodetic products, and is now being expanded to include commercial requirements.

BIIF is under development as a joint ANSI/ISO standard and as of July 97 it is a Draft International Standard. NITF is ratified as a military standard and is implemented. NATO is sponsoring the development of the National Secondary Image Format (NSIF) which also originated from NITF and it is currently a Ratification Draft. It is very likely that the NSIF will become the U.S. profile to BIIF and that a NITF profile to BIIF would be a subset of the NSIF requirements. SRPBE Annex A includes by reference the NITF profile to BIIF (currently MIL-STD 2500B.)

The SRPBE was developed by the ad-hoc working group which consisted of the following members:

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We gratefully acknowledge the contributions and support of the following:

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1.6 Maintenance Authority

The maintenance authority for the base of The SDTS Raster Profile with BIIF Extension resides with the US Geological Survey, National Mapping Division. The maintenance authority for the NITF profile to BIIF resides with the National Image and Mapping Agency. Therefore, the maintenance of the SDTS Raster Profile with BIIF Extension will be accomplished by a collaborative effort between the US Geological Survey, National Mapping Division and the National Image and Mapping Agency.

1.7 BIIF Extension

Profile Annex A of the SRPBE establishes the specifications of the integrated raster capabilities of SDTS and BIIF. This integration of standards will provide a foundation for interoperability in the interchange of raster grid, imagery and imagery-related data among applications. The inclusion of a BIIF extension by this SDTS profile provides an extended image data format providing a container for raster, symbol, and text, along with a mechanism for including image-related support data. The BIIF extension is contained in a normative annex and thus its use is optional. Annex A is intended to be equivalent to the NITF profile to BIIF.

1.7.1 Profile Annex Options

Annexes of the SRPBE contain informative descriptions and permitted options (in normative annexes.) The options implement additional features of the SDTS which may be useful in some transfers. Encoders and decoders are not required to implement these options to conform to SRPBE. However, the presence of these options shall be tolerated by decoders.

Annex A permits the use of BIIF. Annex B permits the transferring of color look-up tables using the Color Index module. Annex C permits the transferring of compressed raster data. Annex D permits special purpose data transfers.

1.8 Definitions

Bands - commonly used in describing imagery; usually collected at the same time by the same acquisition device. For an image, a group of representation modes such as those visible to the human eye and those detected by other means such as infrared, side-aperture radar, electro-magnetic, etc.

Block - rectangular portion of an image; there is no overlapping of blocks or gaps between adjacent blocks within a single image (BIIF Clause 4.2.5.1.)

Cell - used in this document to refer to both the terms grid cell of a data grid and pixel of image data.

Data Segment - In BIIF this refers to one section of a BIIF file, as in an image, symbol, or text segment.

Digital Image - A two-dimensional array of regularly spaced picture elements (pixels) constituting a picture. (SDTS Part 1, Section 2.3.5.1)

Geometric Transformation - an operation that redefines the spatial relationship between points in an image. This includes simple translation, scale, rotation, or something as elaborate as a convoluted transformation. Also called warping.

Georeferenced data - data that has been geographically registered to the earth's surface.

Grid - A two-dimensional set of grid cells forming a regular (i.e. square, equilateral triangle, or regular hexagon), or nearly regular (i.e., rectangle, non-square parallelogram, or non-equilateral triangle), tessellation of a surface. (SDTS Part 1, Section 2.3.5.2)

Grid Cell - A two-dimensional object that represents the smallest non-divisible element of gridded raster data (SDTS Part 1 Section 2.3.3.5). (Similar to a pixel for an image.)

Image - uses a two-dimensional reference system and has zero, one, or more data values associated with each cell. Although image has a visual connotation to it, it is often used to refer to any measurement from a remote sensing device that has a two-dimensional spatial orientation. An image may consist of one or more bands. (See Digital Image)

Indirect georeferencing - locating spatial data to the earth's surface using place names or feature names.

Layer - a set of data values (i.e., cell values) all measuring the same phenomena for an image or grid. In SDTS terms, a "layer" refers to one band of an image or a raster grid. For example, if a three-band image was transferred along with a digital elevation grid, this would constitute four layers in SDTS.

Mosaicking - the joining together of several images that may overlap each other to create a single new image.

Pixel - A two-dimensional picture element that is the smallest non-divisible element of a digital image (SDTS Part 1 Section 2.3.4.1). (Similar to a cell of a grid.)

Pixel Transformation - see Warp.

Radiometric [camera] calibration - The calibration of a camera for its spectral recording characteristics.

Radiometric linearity - The gray levels are in linear proportion to the light intensities within a color band.

Radiometric non linearity - The analog to digital conversion system that provides signal to noise (S/N) ratios of the sensors, where the S/N is calculated by the difference of the sensor's average dark signal value divided by the root

mean square dark noise value. Intermediate intensities will be linear representations from average white reference to the average dark reference. Intermediate intensities will be represented using a linear tonal transfer curve for each color channel. For example, the error introduced during the digitization process causes gray scale values for a color component (RGB) to be out of linear proportion to the source intensities for that component.

Raster object - One or more related raster data layers collected and/or processed together, registered to a common scan reference system and having similar geographic extents. (SDTS Part 1, Section 2.3.7.2)

Rectification - In photogrammetry, the process of projecting a photograph onto a horizontal reference plane. A rectified print is a photograph in which displacement has been removed from the original negative, and which has been brought to a desired scale.

SDTS Transfer - A spatial data set composed of metadata and one or more data files. The metadata portion of the transfer defines lineage, positional accuracy, security restrictions, definitions of feature and attribute terms, etc. and content of the SDTS transfer.

Synthetic raster data - data derived by digitizing or extensive processing. An example is a scanned map image. Also called derived, symbolized, interpreted, exploited.

Tagged Record Extension - A way to provide additional attributes about standard BIIF data segments not contained in the BIIF standard headers. (BIIF Clause 4.2.8.1)

Tile - same as block. A tiled image is equivalent to blocked image.

Transformation - (Photogrammetry) The process of projecting a photograph (mathematically, graphically, or photographically) from its plane onto another plane by translation, rotation, and/or scale change. The projection is made onto a plane determined by the angular relations of the camera axes and not necessarily onto a horizontal plane.

Visual Representation - for the purposes of this profile, this term is used to indicate a critical need to display the image exactly as the image was generated.

Warped Grid - a two-dimensional set of warped grid cells that are adjacent , non-overlapping, and some cells are not square. (For example, remotely sensed imagery that has not been rectified, or a scanned image that has not had scanner distortion removed.)

1.9 Acronyms

ANSI - American National Standards Institute

BIIF - Basic Image Interchange Format

CGM - Computer Graphics Metafile

DR - Data Record (ISO 8211 term)

DDR - Data Descriptive Record (ISO 8211 term)

DDF - Data Descriptive File (ISO 8211 term)

FIPS - Federal Information Processing Standard

FGDC - Federal Geographic Data Committee

GI - SDTS sequencing code for Band Sequential

GJ - SDTS sequencing code for Band Interleaved by Line

GL - SDTS sequencing code for Band Interleaved by Cell

ISO - International Standards Organization

IEC - International Electrotechnical Commission

NIMA - National Imagery and Mapping Agency

NITFS - US National Imagery Transmission Format Standard

NSIF - NATO Secondary Interchange Format

RMSE - Root Mean Square Error

SDTS - Spatial Data Transfer Standard

SRPBE - Spatial Data Transfer Standard Raster Profile with BIIF Extension

USGS - U.S. Geological Survey

1.10 Conformance and testing

(see also SDTS Part 1, Section 1.2, Conformance and BIIF clause 5 Conformance profiles and extensions)

There are three types of products/aspects which can be tested or evaluated for conformance to SRPBE. Depending on the product capability being evaluated, one or more of the following aspects will be utilized to measure compliance:

(a) SDTS transfers (the actual data sets);

(b) SDTS encoding software; and

(c) SDTS decoding software.

1.10.1 Transfer Conformance

In order to conform to this SRPBE a transfer shall:

(a) contain all mandatory spatial objects, modules, fields, and subfields as specified in SRPBE;

(b) not contain spatial objects, modules, fields, and subfields which are not permitted by SRPBE or its annexes;

(c) conform to all applicable requirements and specifications of BIIF and Parts 1, 2, and 3 of SDTS unless they conflict with SRPBE; (profile takes precedent)

(d) conform to all restrictions of SDTS Parts 1, 2, 3 and as specified in SRPBE;

(e) be formatted in compliance with ISO 8211 or Annex A if the BIIF is used for the image data;

(f) follow all module and file naming requirements of SRPBE;

(g) contain any profile options it claims to include; and

(h) adhere to all other requirements specified in SRPBE.

1.10.2 Encoder Conformance

In order to conform to this SRPBE, an encoder shall:

(a) generate only SRPBE transfers which conform to Section 1.2.1 (or be able to be directed to only generate transfers which conform to SRPBE);

(b) convert spatial objects in the input system to appropriate SDTS spatial objects;

(c) convert attribute data stored in the input system (such as in a data base) to SDTS Attribute Primary and Secondary modules;

(d) correctly maintain linkages between spatial objects and attributes;

(e) encode raster formats, with the choice of data type (i.e., integer, real, etc.) specified by the user at the time of encoding, and, as an option, be able to create a single transfer with different precessions (i.e., 8-bit, 32-bit, etc.) for each separate layers; and

(f) properly implement all profile options it claims to support.;

1.10.3 Decoder Conformance

In order to conform to this SRPBE, a decoder shall:

(a) be able to interpret any SRPBE transfer which conforms to Section 1.2.1;

(b) be able to decode any module required or permitted by the body of SRPBE;

(c) be able to decode any spatial object required or permitted by section 2.1 of SRPBE and, to the fullest extent possible, convert it to the receiving systems' corresponding object or equivalent information structure;

(d) be able to decode any Attribute Primary or Secondary Module and convert it to a data base or other format usable by the receiving system;

(e) correctly maintain linkages between spatial objects and Attribute Primary records;

(f) decode multiple precision raster formats, as necessitated by the data type format used in the encoded transfer files; when data precision exceeds system capability then provide notification of action taken;

(g) be able to tolerate the presence of modules, fields, and subfields which are permitted by profile annexes which the decoder does not support;

(h) be able to recover if an error is encountered in a particular record, field, or subfield in the SRPBE transfer;

(i) report to a file or output device information describing the position of errors encountered in the SDTS transfer, including Module Name, Record ID, tag, and label of the last successfully decoded data element and, if possible, the Module Name, Record ID, field tag, and subfield label of the data element containing the error; and

(j) properly implement all profile options it claims to support;

(k) be able to decompress all permitted compression methods.

2 RASTER DATA Concepts

2.1 Spatial Objects

(see SDTS Part 1, Section 2.3 Definition of Spatial Objects)

The SRPBE permits only the Digital Image or Grid (object code G2) and the Warped Grid Image (object code of G2W) spatial objects. All other object representation codes are not permitted. A conformant transfer must contain at least one G2 or G2W object. This profile further restricts the Grid Cell and Pixel spatial objects to be rectangular (i.e., hexagons, triangles, parallelograms, etc. are not permitted.) or warped (i.e. pixel edges are curved). For the purposes of this profile a *Grid* shall be defined as a two-dimensional array of rectangular or warped grid cells forming a tessellation of a surface. And similarly, the *Digital Image* shall be defined as a two-dimensional array of regularly spaced or warped picture elements (pixels) constituting a picture.

A conforming encoder or decoder must be able to encode or decode the required G2 object representation code. And, for the G2W object code a decoder must be able to display it as if it is a G2 code with appropriate warnings to the data consumer. Full support of the G2W object representation code is optional for conforming encoders and decoders.

In this profile, the term *raster* shall be used to collectively refer to both digital image and grid, and the term *cell* shall be used to collectively refer to both grid cell and pixel, unless otherwise noted.

2.2 Multiple Raster Objects, Layers, and Partitions

The SRPBE permits one or more raster objects to be contained in a single transfer. A raster object may consist of one or more layers with the restriction that all layers of a single raster object have the same geographic extents (i.e., cover the same portion of the earth's surface), and use the same raster object scan reference system (i.e., cell address 2,3 refers to the same cell location in every layer.) The raster objects may occupy the same, overlapping, or different horizontal partitions of the earth's surface.

The data encoder is permitted to encode multiple raster objects in a single transfer, but should be warned that the relationship between the raster objects is undefined. The relationship between the multiple raster objects or between the multiple layers of a single raster object shall be explained in the SDTS Logical Consistency Module.

The SRPBE permits the simultaneous use of both SDTS and BIIF. For example, an SDTS grid may be used to encode a layer of elevation data and the BIIF image may be used to encode an orthoimagery layer of the same geographic extent.

BIIF Note: A BIIF file is permitted to include multiple images. Each image can have one or more bands.

2.3 Non-ragged Grids

(see SDTS Part 1, Section 5.7.6.3 (Raster) Data Dictionary Domain)

The SRPBE requires a raster grid to be non-ragged. A data encoder can define a "fill value" to convert a ragged grid to a non-ragged grid. In SDTS a raster layer is defined by a Layer Definition module record. This layer is

further defined by the Data Dictionary module records. An associated Data Dictionary Domain module record(s) defines which pixel value means data not present, and any other special pixel values.

BIIF Note: If the image data to be encoded is ragged then padding or transparent pixels must be used. BIIF uses "masking techniques" to identify non-valued, or transparent pixels within an image (see BIIF Clause 4.2.5.2). If an image is partitioned into equal size tiles/blocks, then padding can also be used to fill an empty portion of a block.

2.4 Nongeospatial dimensions

The use of nongeospatial dimensions is not permitted by SRPBE. SRPBE only permits the transfer of two dimensional raster data in the x,y coordinate space. (The z coordinate is not permitted in the spatial address. Elevation data values are permitted to be transferred as a raster grid layer under this profile.)

2.5 Raster Scan Reference System

(see SDTS Part 1, Section 5.7.7)

SDTS raster modules permit the definition of a raster object scan reference system and layer scan reference system which are different. The SRPBE requires that the raster object scan reference system and the layer scan reference system be identical so no coordinate conversion is required (i.e. the layer coordinate and the raster object coordinate are the same.) The SRPBE requires that the scan origin be located at the top left and the scan pattern be linear and the scan direction be row.

2.6 Band Interleaving (Cell Sequencing Code)

(see SDTS Part 1, Section 5.7.1.1. Raster Definition Module)

SRPBE permits the cells of a raster object to be sequenced in one of three modes: layer sequential (code GI), layer interleaved by line (code GJ), or layer interleaved by pixel (code GL). Only layers from the same raster object are permitted to be interleaved. All layers of the same raster object must be interleaved in the same manner (i.e., not permitted to interleave layers one and two and leave layer three sequential.) A raster object with one layer must be denoted as code GI.

BIIF Note: (BIIF Clause 4.2.5.4.2) The band interleaving options permitted are by pixel, block, and row as defined for BIIF element IMODE.

2.7 Warped Grid Raster

No standard mechanism is provided to rectify geospatial imagery. In transferring a warped grid image (non-rectified), the geometric correction information is of utmost importance for the correct utilization of the imagery. The geospatial community recognizes the need for standardization of these geometric correction parameters, however, no single standardized set has been developed as of this writing. SRPBE recommends that for the transfer of geometric correction parameters, a widely accepted industry standard be used. Geometric correction parameters should be passed along with the image data or at a minimum referenced to provide the receiver of the data with enough information to identify the appropriate system(s) for processing.

The SRPBE will permit the transfer of warped grid images. To indicate the transfer of a warped grid image, the object representation code of G2W will be used. A decoder that cannot perform automatic rectification shall

minimally display the image as a normal grid and warn the data user that this has been done. The data encoder must encode the geometric correction parameters in SDTS Attribute Primary Module(s) records that are referenced by the Raster Definition Module record.

2.8 Tesseral Indexing/Blocking

(see SDTS Part 1 Section 2.3.5.2 Grid (G2) and BIIF Clause 4.3.5.1 Blocked Images)

Tesseral indexing is not permitted in SDTS.

BIIF Note: Blocked images are permitted. If compression is used, the entire image (each tile) must be compressed using the same algorithm. If interleaving is used, each tile must be interleaved in the same fashion.

2.9 Compression

(see SDTS Part 1 Section 5.9.4 The Coding Module)

Compression is not permitted. (Compression is permitted in optional annex C.) However, decompression is required to be supported. This requirement is based on the assumption that compressing is more complex than decompressing, and that data encoders can optionally chose to implement compression. A data decoding capability shall support decompression as described below to facilitate data exchange.

Decompression of run length encoding as described in SDTS Part 1 Section 5.9.5 shall be supported. Decompression of JPEG as described in SDTS Part 1 Section 5.9.7.1 shall be supported.

BIIF Note: The NITF Profile to BIIF requires decompression of VQ, Bi-level, and JPEG (lossy and lossless), and compression using JPEG. Compression using VQ and bi-level are optional.

3 Spatial Data Quality

(see SDTS Part 1, Section 3 Spatial Data Quality)

In addition to SDTS Part 1, Section 3 the following requirements must be satisfied.

3.1 Lineage

A report of lineage must include a description of the source material and how it was used. The Federal Geographic Data Committee (FGDC) Content Standards for Geospatial Metadata, Section 2.5 elements are highly recommended.

For a remotely sensed image, radiometric information is of utmost importance for correct utilization of the imagery. The SDTS is capable of encoding this information, however, no single standardized set of radiometric parameters has been developed. Any parameters encoded as SDTS attributes need to be fully defined using the SDTS Data Dictionary modules. The Lineage Module should contain a description of how to apply the parameters or reference a document that describes the process.

Separate processing histories pertaining to, for example, separate raster data layers, shall be documented. If data are collected from an aerial photograph, then a statement explaining the rectification process is required. If the raster has undergone multiple lossy compression's, then a report regarding the compression history is required.

In general, the more that has been done to the raster data, the more there is to put in the Lineage report. The figure below shows a progression of raster products with increasing lineage reporting requirements proceeding from left to right.

Raster Spectrum - from Natural to Synthetic					
Remote Sensing Thematic Mapper -LandSat	Aerial Photograph scan	Rectified Aerial Photo Scan	Map/Chart Scan	Regular Point Grid	Feature Coded; Land characterization

BIIF Note: Lineage information is carried in the History Tagged Record Extension and the Geospatial Support Data Extension.

3.2 Positional Accuracy

In reporting positional accuracy, use of a standard reporting method is required. If no other standard reporting method applies, the FGDC Content Standards for Geospatial Metadata, Section 2.4 elements should be used for encoding.

BIIF Note: NSIF Annex D outlines the Standard Geospatial Support Data Extensions (SDE) through which accuracy data can be included in a BIIF file. BIIF SDE also supports reporting of positional accuracy that varies by region within a dataset coverage area.

3.3 Attribute Accuracy

For raster data, attribute accuracy refers to the accuracy of the pixel/cell values for a layer or overlay.

For qualitative or categorical attributes, such as land classification or soil type (non-numeric), attribute accuracy is a degree of the reliability of the measurement. For quantitative attributes , such as elevation or temperature values, the accuracy data is a statistical measurement, i.e. standard deviation, or root mean square error (RMSE).

If the raster layer contains elevation measurements, use the Positional Accuracy Module to describe the accuracy of the elevation measurements.

3.4 Logical Consistency

Logical consistency addresses the fidelity of the relationships between spatial objects. With regard to raster data, this addresses the relationships between grids, images, and layers. There are already subfields in the raster modules for describing the number of layers and bands and what each represents. The Data Quality/Logical Consistency module "comment" field shall include other information (as textual narration) that would be useful for human-interpretation. If multiple images or grids are included in the transfer then the relationship between the images shall be described.

BIIF Note: If BIIF is used to encode image and sub-image relationships, a statement to this effect should be included in the Logical Consistency Module. If the visual representation of the raster data is also being transferred, include statements in the Logical Consistency module that describe why the visual representation is included and how the information is being included. If BIIF is to be used for display control on a receiver's

system, then include a statement in the Logical Consistency module explaining this and to what extent the display is being controlled. For a BIIF image file, a mechanism for specifying display levels and attachment levels assigns a hierarchy coding to each element of the image.

3.5 Completeness

(see SDTS Part 1, Section 3.5 Completeness)

If pad values or transparent pixels are used, then state that they are present and why, if applicable.

4 General Specification

(see also SDTS Part 1, Section 4.1.3, The Transfer Model)

4.1 Standard Module Names

The SRPBE module names (the unique name of each individual module) shall be standardized, and consist of four characters according to the following rules.

All modules shall be named the same as the primary module field mnemonic. For any module type that can occur multiple times in a transfer, the last 1, 2, or 3 characters of the name can be used to show a series. For example, if a particular SDTS raster transfer contained three distinct Cell modules, the encoder could choose CEL1, CEL2, and CEL3 as the module names. Cell modules shall not be named CATD, CATX, CATS, CLRX, or CODE.

Modules types that can occur more than once in a transfer, and whether 1,2, or 3 characters can be varied, are designated in the table in Section 5.0.

The complete list of standard module names is:

-IDEN (Identification),

-CATD (Catalog/Directory),

-CATX (Catalog/Cross Reference),

-CATS (Catalog/Spatial Domain),

-SCUR (Security),

-IREF (Internal Spatial Reference),

-XREF (External Spatial Reference),

-RGIS (Registration)

-SPDM (Spatial Domain),

-DDDF (Data Dictionary/Definition),

-DDOM (Data Dictionary/Domain),

-DDSH (Data Dictionary/Schema),

-STAT (Transfer Statistics),

-DQHL (Data Quality/Lineage),

-DQPA (Data Quality/Positional Accuracy),

-DQAA (Data Quality/Attribute Accuracy),

-DQLC (Data Quality/Logical Consistency),

-DQCG (Data Quality/Completeness).

-CLRX (Color Index)

-CODE (Coding)

-RSDF (Raster Definition)

-LDEF (Layer Definition)

-Cnnn (Cell) (cannot be CATD, CATX, CATS, CLRX, CODE)

-Annn (Attribute Primary)

-Bnnn (Attribute Secondary)

4.2 Order of Records, Fields, and Subfields within Modules

Records within modules shall be ordered, in ascending order, by Record ID. But the actual Record ID integer values need not start with "1," and records in sequence may skip integers arbitrarily, up to (2^{-1}).

The subfields within fields and fields within records shall be ordered as in the SDTS module specification layout tables found in SDTS Part 1, Section 5.

4.3 Spatial Address (Coordinates) and Reference System

(see also SDTS Part 1, Section 4.1.3.5, Spatial Registration)

There shall be only one external coordinate frame of reference within a transfer. SDTS External Spatial Reference Conformance level 1, 2, or 3 (unspecified) is permitted. Level 2 projections must be known and well-defined. Level 3 indicates indirect referencing or a warped grid (non-Cartesian) system, with an unspecified relationship to latitude and longitude.

Each raster object may have its own internal coordinate system (referenced to the external spatial reference system by translation and scaling parameters in an Internal Spatial Reference module record). Horizontal and vertical datums are specified in the External Spatial Reference module under the HDAT and VDAT subfields respectively.

BIIF Note: (see NSIF Annex D Geospatial SDE) - Each image can have its own external spatial reference system.

4.4 External Spatial Reference

(see SDTS Part 1, Section 5.2.4.2 External Spatial Reference)

For External Spatial Reference Conformance level 1,

a) The External Spatial Reference EXSR subfield of the Conformance field of the Identification Module shall have the value "1" indicating that, YES, one of three recommended systems is used; and,

b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field shall have the value "GEO", "SPCS", "UTM", or "UPS".

For External Spatial Reference Conformance level 2,

a) The External Spatial Reference EXSR subfield of the Conformance field of the Identification Module shall have the value "2" indicating that a projection other than the three recommended systems is used;

b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field shall have the value "OTHR";

c) The Projection PROJ subfield in the External Spatial Reference Module primary field shall have the name and (or) description of the projection and reference system used; and,

d) The Reference Documentation RDOC subfield in the External Spatial Reference Module shall contain the document where the projection is defined. It is recommended that the projection named be defined in the General Cartographic Transformation Package (GCTP[1]).

For External Spatial Reference Conformance level 3,

a) The External Spatial Reference EXSR subfield of the Conformance field of the Identification Module shall have the value "3" indicating that georeferencing is unspecified (because a warped grid, or indirect,

b) The Reference System Name RSNM subfield in the External Spatial Reference Module primary field shall have the value "UNSP"; and,

c) The Reference Documentation RDOC subfield in the External Spatial Reference Module may contain the document where the rectifying method is described, if applicable.

4.4.1 Internal Representation of Spatial Addresses

The internal representation of X and Y coordinates shall be as 32-bit signed implicit fixed point binary numbers ("BI32" SDTS data type). Signed integers are represented in "two's complement" format as defined in ANSI X3.122 - 1986 SDTS Part 3, Section 5.1, pages 10-11. This standard requires "big-endian" bit ordering in which the most significant bit is stored first (see also ISO 8632-3, and SDTS Part 3, Section 9.3, Binary Data.)

[1]) GCTP is the General Cartographic Transformation Package developed by the US Geological Survey and National Oceanic and Atmospheric Administration. Refer to: Snyder, J.P., 1987, Map projections - A working manual: U.S. Geological Survey Professional Paper 1395, 383 p. and/or GCTP Software Documentation.

Internal fixed point coordinates can be converted to external coordinates by converting to floating point and applying the scaling and translation values from an Internal Spatial Reference module--(see SDTS Part 1, Sections 5.2.4.1 Internal Spatial Reference, and 5.7.7.1 Rules for assigning Layer Coordinates to Cell Values)

4.4.2 Restrictions on X and Y Subfields

For level 1 External Spatial Reference conformance, the X subfield of spatial addresses shall only be used to transfer longitude and easting values. The Y subfield shall only be used to transfer latitude or northing. The raster's Spatial Address field (mnemonic SADR) is in the Cell module.

4.4.3 Restrictions on the Dimension ID field of the Internal Spatial Reference module

The Dimension ID field will not be present, since higher than two-dimensional rasters are not permitted.

4.5 NULL (and Like) Values

(see also SDTS Part 1, Section 4.1.3.3.9, Nulls and Defaults)

When a transfer uses fixed length fields in an ISO 8211 file, special consideration must be given to handling NULL values. NULL values are defined in two general categories:

a. undefined, not relevant

b. relevant, but unknown or missing

Null values are determined by the data encoder. When appropriate, the following text shall be encoded in the Comment subfield of a Logical Consistency module record, and implemented:

When a subfield, either user-defined in Attribute Primary and Attribute Secondary module records, or in other SDTS module records, is implemented as fixed-length, the following null scheme is used:

a. when information to be encoded in the subfield is known to be not applicable (undefined, not relevant), then the subfield is valued by a string of spaces; and

b. when the information to be encoded is relevant but unknown (or missing), then the subfield is valued by a string of question marks "?".

The Logical Consistency module with the above text shall be associated to applicable modules through the Catalog/Cross Reference module.

4.6 Attributes

(see also SDTS Part 1, Annex B, Section B.6 Suggested Code Sets)

SRPBE highly recommends the use of established FIPS codes where applicable, such as FIPS PUB 6-4 (31 August 1990) Counties and Equivalent Entities Codes. SRPBE permits any level of feature conformance (1-4), but highly recommends the use of standardized entities (i.e., layer names for raster) and attributes.

The entire raster or any of its layers may have attributes. Attributes are not permitted on individual pixels or cells.

4.7 Relationships Between Modules and Raster Objects

There must be one Raster Definition module, one Layer Definition module, at least one Cell module and one Internal Spatial Reference module. The Raster Definition module may have one or more records - one record for each raster object. The Layer Definition module contains one record for every raster layer. The Cell module(s) contain the Cell data for the raster layers.

5 Transfer Module Specification

(see also SDTS Part 1, Section 5, Transfer Module Specification)

This section addresses the module level restrictions as they apply to a transfer. Certain requirements of SDTS Part 1 are repeated here for clarity. Following the module level restrictions/requirements, any restrictions on field/subfield values are noted for each module. The order of coverage follows that of SDTS Part 1, Section 5. These two modules appear in the following tables under the Raster Modules section, between the existing Raster Definition and Cell modules.

Table 5.0 contains the inclusion, exclusion, and cardinality rules for each module. The standardized module names are included, along with the minimum and maximum number of occurrences of the module type. A lowercase "n" indicates that the upper limit is user defined. Any lowercase letters or dots in the module name has the meaning explained in Section 4.1 in this document, Standard Module Names.

Module level Restrictions and Requirements			
Module Type	Name	Min. No.	Max. No.
Global Information Modules (see also SDTS Part 1, Section 5.2, Global Information Modules			
Identification	IDEN	1	1
Catalog/Directory	CATD	1	1
Catalog/Cross Reference	CATX	1	1

Module level Restrictions and Requirements			
Catalog/Spatial Domain	CATS	1	1
Security	SCUr	0	n
Internal Spatial Reference	IREf	1	1
External Spatial Reference	XREF	1	1
Registration	RGIS	0	n
Dimension Definition	DMDF	0	0
Spatial Domain	SPDm	0	n
Data Dictionary/Definition	DDDf	1[2]	n[3]
Data Dictionary/Domain	DDOm		n
Data Dictionary/Schema	DDSh	1	n
Transfer Statistics	STAT	1	1
Data Quality Modules (see also SDTS Part 1, Section 5.3, Data Quality Modules)			
Lineage	DQHl	1	n
Positional Accuracy	DQPa	1	n
Attribute Accuracy	DQAa	1	n
Logical Consistency	DQLc	1	n
Completeness	DQCg	1	n
Attribute Modules (see also SDTS Part 1, Section 5.4, Attribute Modules)			
Attribute Primary	A...	0	n
Attribute Secondary	B...	0	n
Raster Modules (see also SDTS Part 1, Section 5.7, Raster Modules)			
Raster Definition	RSDF	1	1
Layer Definition	LDEF	1	1
Cell	Cnnn[4]	1	n[5]
Graphic Representation Modules (see also SDTS Part 1, Section 5.8, Graphic Representation Modules)			
Color Index	CLRx	0	n
Text Representation	TEXT	0	0
Line Representation	LNRP	0	0
Symbol Representation	SYRP	0	0
Area Fill Representation	AFIL	0	0

[2]) The DDDF defines each raster layer, the DDSH defines the format for a layer's cells, and the DDOM provides the minimum and maximum as well as special, or enumerated, cell values for each layer.

[3]) A maximum of one module is recommended.

[4]) Where nnn is any combination of numbers or alpha characters

[5]) No more Cell modules than total layers in a transfer and no fewer Cell modules than total number of Raster Objects in a transfer.

Module level Restrictions and Requirements			
Font Index	FONT	0	0
All Vector Modules	--	0	0
Composite Modules	FF..	0	0
Compression, Compaction and Encryption Module (see also SDTS Part 1, Section 5.9)			
Coding	CODE	0	1

5.1 Global Information Modules

5.1.1 Module Restrictions/Requirements: Identification Module

(see also SDTS Part 1, Section 5.2.1 and Table 10, Identification)

There shall be only one Identification module, and it must contain at least one record.

Specific subfield requirements/restrictions:

a) The Profile Identification PRID subfield shall have the value "SRPBE: SDTS RASTER PROFILE WITH BIIF EXTENSION".

b) If options described in the Normative Annexes of this profile are implemented in a transfer, each implemented annex shall be indicated by adding a "/" and the upper case letter of the annex to the Profile Identification subfield. Any combination of annexes may be implemented in a transfer. For example, if a transfer implements Annex A, Profile Identification would contain "SRPBE: SDTS RASTER PROFILE WITH BIIF EXTENSION /A".

c) The Profile Version PRVS subfield shall have the version identifier followed by the cover date of the profile as follows: VER 1.0 YYYY month

d) The Profile Document Reference PDOC subfield shall contain “Federal Geographic Data Committee (FGDC) Standard: SDTS PART 5 ” and any applicable document control numbers.

e) The External Spatial Reference subfield shall have the value of "1" indicating that, YES, one of the three recommended systems identified in Section 4.4.1 of this document is used; or the value "2" indicating that another projection, besides those in level 1, is being used; or “3” indicating that indirect referencing is used or that a warped grid image is being transferred.

f) Any level of SDTS Features Conformance is allowed (the value in the Features Level subfield (FTLV) of the Conformance field of the Identification module record shall be either "1", "2", "3" or "4"). Note that if SDTS is not the authority for any entity and attribute term, then the Features Level subfield must be valued as "4".

g) The Attribute ID field is permitted and is used to reference global information (i.e., metadata) that applies to the entire transfer.

5.1.2 Module Restrictions/Requirements: Catalog/Directory

(see also SDTS Part 1, Section 5.2.2.1 Catalog/Directory)

So that the contents of a transfer are independent of the transfer media, the following restrictions are placed on the primary field of the Catalog/Directory module:

a. The Volume subfield shall not be used.

b. The File subfield shall not include a directory path, only a file name meeting the requirements of Section 6.5 of this document.

5.1.3 Module Restrictions/Requirements: Catalog/Spatial Domain

(see also SDTS Part 1, Section 5.2.2.3 Catalog/Spatial Domain)

The following requirements apply to the Catalog/Spatial Domain field in the Catalog/Spatial Domain module:

a. Either the Domain or Map subfields or both are required so that the coverage of the module is indicated.

b. The Theme subfield is required for all data sources which separate data into themes.

c. Where appropriate, the Aggregate Object Type subfield shall contain the raster object representation codes (G2 and G2W) indicating that the module references a raster.

5.1.4 Module Restrictions/Requirements: Internal Spatial Reference

(see also SDTS Part 1, Section 5.2.4.1 Internal Spatial Reference)

The X subfield of spatial addresses shall be used only for longitude, easting, or equivalent values. The Y subfield shall be used only for latitude, northing, or equivalent values. Therefore, for SDTS level 1 External Spatial Reference conformance, the Spatial Address X Component Label subfield is restricted to "LONGITUDE" when the external spatial reference system is geographic and "EASTING" when the external spatial reference system is UTM/UPS or SPCS. Also for level 1 conformance, the Spatial Address Y Component Label subfield is restricted to "LATITUDE" when the external spatial reference system is geographic and "NORTHING" when the external spatial reference system is UTM/UPS or SPCS.

The Scale Factor X, Scale Factor Y, X Origin, and Y Origin subfields in the Internal Spatial Reference field are required. These subfields specify the scaling and translation required to transform spatial addresses from the internal spatial reference to the external spatial reference (see SDTS Part 1, Section 5.2.4.1 Internal Spatial Reference). The Registration module can also be used to specify this transformation. If the Registration module is used to convert from internal to external coordinates, subfields containing scaling factors and the origin of the external system are optional. Otherwise, the subfields are mandatory and shall not be null. If no transformation is

required, the identity transformation shall be indicated by scaling factors of 1.0 and components of the origin of 0.0.

The Internal Spatial Reference module describes the resolution for the spatial dimension. The units and coordinate system for the resolution is defined by the External Spatial Reference module. The X Component of Horizontal Resolution (XHRS), Y Component of Horizontal Resolution (YHRS), and the Vertical Resolution Component (VRES) subfields shall be real numbers.

5.1.5 Module Restrictions/Requirements: External Spatial Reference

(see also SDTS Part 1, Section 5.2.4.2 External Spatial Reference)

There shall be only one External Spatial Reference module per transfer, with only one record. All spatial data in the same SDTS transfer shall be referenced to the same external spatial reference system.

The Reference System Name RSNM subfield shall have the value "GEO", "SPCS", "UTM", "UPS", or "OTHR" depending upon the external spatial reference system being used. In the case of a G2W object, the value “OTHR” must be used.

5.2 Data Quality Modules

(see also SDTS Part 1, Section 5.3, Data Quality Modules)

A common set of Data Quality modules may be used for an entire series of files to be distributed. These data Quality modules may be made available separately; and they need not be duplicated within each SDTS transfer. If

the SDTS Data Quality modules are separate from the individual SDTS transfer data set, then they shall be uniquely identified and referenced by the individual SDTS transfer data set. (See SDTS Part 1, Sections 4.1.3.3.1 Modules within a Spatial Data Transfer (clause (e)), and 5.2.2.1 Catalog/Directory, subfields External and Module Version.)

5.3 Attribute Modules

(see also SDTS Part 1, Section 5.4, Attribute Modules)

Attribute modules are allowed for SRPBE. Attributes can be specific to individual layers and/or to the entire raster, but not to individual cells within the raster.

5.4 Composite Modules

These modules shall not be included in a transfer conforming to SRPBE.

5.5 Vector Modules

These modules shall not be included in a transfer conforming to SRPBE.

5.6 Raster Modules

(see also SDTS Part 1 Section 5.7 Raster Modules)

A transfer complying to SRPBE can be either the default or non-default implementation. If the transfer is a default implementation, rules in SDTS Part 1, Section 5.7.3 Default Implementation, regarding subfield name and default value apply. The default implementation is strongly recommended for raster transfers.

5.6.1 Module Restrictions/Requirements: Raster Definition

a) One Raster Definition module record represents one raster object.

b) One Raster Definition module may have one or more records.

c) One Raster Definition module record may have one or more Layer Id fields.

d) Each Raster Definition module record must reference different Layer Definition module records.

e) For object code G2W, the data encoder may optionally encode the geometric correction parameters in SDTS Attribute Primary Module(s) records that are referenced by the Raster Definition Module record.

5.6.1.1 Specific subfield restrictions:

a) Object representation code OBRP shall be G2 or G2W.

b) Cell Sequencing Code CSCD shall be GI or GJ or GL.

c) Default Implementation DEFI shall be DEF (highly recommended) or NON.

d) Scan Origin SCOR shall be TL (top left origin).

e) Scan Pattern SCPT shall be LINEAR.

f) Tesseral Indexing TIDX shall be NOTESS.

g) Number of Lines per Alternation ALTN shall be one.

h) First Scan Direction FSCN shall be R (by row).

5.6.2 Module Restrictions/Requirements: Layer Definition

a) One Layer Definition module may have many records.

b) One Layer Definition module record describes one layer of a single raster object.

c) One Layer Definition module may contain records describing layers from one or more raster objects.

d) Each Layer Definition module record may be referenced by one and only one Raster Definition module record.

e) One Layer Definition module record will reference one Cell module. More than one Layer Definition module record can reference the same Cell module, and this means that the layers' cell values are interleaved (code GJ and GL). If no interleaving (code GI), then each layer has its own Cell module.

5.6.2.1 Specific subfield restrictions:

a) Number of Rows NROW subfield shall be equal to the value Row Extent RWXT of the referencing Raster Definition module record.

b) Number of Columns NCOL subfield shall be equal to the value Column Extent CLXT of the referencing Raster Definition module record.

c) Scan Origin Row SORI subfield shall be one.

d) Scan Origin Column SOCI subfield shall be one.

e) Row Offset Origin RWOO subfield shall be zero.

f) Column Offset Origin CLOO subfield shall be zero.

5.6.3 Module Restrictions/Requirements: Cell

a) One Cell module may have many records.

b) One Cell module is not permitted to contain cell values from different raster objects. All of the cell values in all of the module records of a Cell module must be for a single raster object.

c) One Cell module is not permitted to contain cell values from different layers, unless the layers are interleaved with code GL or GJ.

d) One Cell module record contains one or more cell values from a single raster object. If the Cell Sequencing code is GI then one Cell module record contains cell values from only a single layer. If the Cell Sequencing code is GL or GJ then one Cell module record contains cell values from every layer of a single raster object.

e) It is highly recommended that a single Cell module record contain a scan lines worth of data, unless this becomes unreasonably long (as defined by current technology.) A single Cell module record may contain part or all of a scan lines worth of data. A single Cell module record shall not contain data that spans multiple scan lines.

All layers which are interleaved must abide by the rules found in SDTS Part 1, Section 5.7.7.1.2 Assigning a Layer Coordinate with Multiple Layers per Cell Module.

5.6.3.1 Specific subfield restrictions/requirements:

a) Row Index ROWI subfield is required.

b) Column Index COLI subfield is required.

c) Cell Values CVLS field is required.

d) Plane Index PLAI subfield is not permitted.

e) Tesseral Index TIND subfield is not permitted.

f) Dimension Index DNDX Field is not permitted.

g) Attribute Id ATID field is not permitted.

h) Cell Coding Foreign Id CFID field is not permitted.

5.7 Graphic Representation Module

(see also SDTS Part 1, section 5.8, Graphic Representation Modules)

These modules shall not be included in a transfer conforming to SRPBE.

5.8 Coding Module

The SRPBE only permits compression of the raster data, not the metadata. The Coding module is used to compress raster data in the Cell module. (See SDTS Part 1, 5.9 Coding module and Annex C.) The only adjunct file allowed is a JPEG JFIF. (Compression is permitted in optional annex C, but decompression is required in this base profile.)

BIIF Note: BIIF as an adjunct file is permitted in optional annex A.

6 ISO 8211 Specific Decisions

(see also ANSI/ISO 8211-1985 a.k.a. FIPS PUB 123 Specifications for a Data Descriptive File for Information Interchange, and SDTS Part 3, ISO 8211 Encoding)

6.1 Objective

(see also SDTS Part 3, Sections 1.1 and 1.2, Purpose and Objectives):

SDTS/ISO 8211 is optimized for retrieval and storage (versus interactive decoding); non-SDTS directories/indices may be added to allow such interactive decoding (e.g. on a CD-ROM media).

6.2 Relationship of Modules to ISO 8211 Files

(see also SDTS Part 1, Section 4.1.3 The Transfer Model, and SDTS Part 3, Section 7, Assignment of Fields to Records and Files)

6.2.1 Relationship of Files

A file (an ISO 8211 Data Definition File (DDF)) shall contain one and only one module. All raster profile files must have only fields from the same module in any particular record and file, i.e. each file will represent only a single module. Normally, a module will only occupy a single file.

6.2.2 Relationship of Modules

A module may span files only when the size of a single file would exceed volume capacity, that is if the file needs to be broken into separate files to be placed on separate volumes, because of media constraints. Thus, modules may be broken into different files only in a multi-volume transfer, and then only if the module cannot fit on a single volume.

6.3 Media

(see also SDTS Part 3, Section 10, Media Requirements)

When only a single transfer is on a transfer volume, the volume name shall begin with the four character base (Base here just refers to the first four characters of an SDTS file name which all files belonging to the same transfer must share: HYDRIDEN.DDF, HYDRCATD.DDF, HYDRLE01.DDF, etc.; the base "name" is "HYDR".) for that transfer. When multiple transfers are contained on a volume, the first four characters of the volume name shall be "SDTS". For multi-volume transfers, the first four characters shall be the transfer base characters, and the whole name shall consistently reflect the volume sequence.

6.4 Organization of Files on Media

In general, files comprising a single transfer shall be kept separate from any other transfer files and organized as follows:

a) On floppy disks and CD-ROM or any random access media, each transfer shall be grouped completely in a single directory. Multiple transfers may reside on the same media volume, with each in its own subdirectory.

b) On magnetic tape or any sequential access media, files of a single transfer shall be ordered by module type, following the order of presentation in SDTS Part 1, Section 5. File adjacency shall be used to group transfer files when multiple transfers reside on the same media volume. All files that follow the Identification Module (first file of a transfer) until another Identification Module or an end of tape marker is encountered shall be considered part of the transfer.

c) A file called "README" is required (see SDTS Part 3, Section 11, Conformance). There shall be one such file per media volume. This file shall reside in the root directory of a floppy disk or CD-ROM, or alternatively, as the first file on a magnetic tape. Contents of the README file is discussed later in this section.

6.5 File Names

For consistency among file names from various agencies, the SRPBE requires that file names begin with a 4 character base followed by the 4 character module name contained in the file.
A single transfer data set shall use the same first four characters in the file name of each SDTS ISO 8211 file in the entire transfer. The next four characters in the file name shall be the unique name of the module transferred in that file (see naming convention for modules in Section 4.1 of Part 4). For example, the files named HY01IDEN.DDF, HY01RSDF.DDF, HY01IREF.DDF would all belong to the same transfer.

When allowed, the file extension should be ".DDx" where “x” is allowed to vary from F through X. For example, if the file HY01IDEN.DDF could not contain all the information required for the “IDEN” module, the remainder of the information would be transferred in files HY01IDEN.DDG, HY01IDEN.DDH, and so on. Any file that is not ISO 8211 compliant (e.g. adjunct files) shall not have the ".DDx" extension. An optional ninth character in the base name may also be used to indicate a module is comprised of more than one file. An example of this convention could be HY01IDEN1.nnn, HY01IDEN2.nnn, and so on, with nnn allowed to be any extension except “.DDx”.

6.6 Taking Advantage of Dropped Leader and Directory

(see also SDTS Part 3, Section 6.4, Repeating Fields and Records)

SRPBE encourages taking advantage of ISO 8211 mechanisms to reduce file size. All modules shall use fixed size fields whenever practical to allow for the dropping of leader and directory information from the data records in ISO 8211. In the case where there are a few records that exceed the fixed size fields' size, records shall be ordered within a file to maximize the use of dropped leaders and directories. This means that exceptional data records (DRs) shall be placed first in the DDF. All records that can share a common leader and directory shall be grouped at the end of the file. (This is necessary because once the leader and directory are dropped, they cannot be specified later in the file.)

Maximizing the use of dropped leaders and directories needs to be taken into consideration when designing attribute modules. If there are attributes that can have a wide range in the size of their value (e.g. place names), then considering separating these attributes into their own module.

6.7 ISO 8211 DDR Contents

a) Data descriptive fields which have no specified labels may be augmented by user-supplied labels for the identification of subfield data. An import system is not required to recognize user-supplied labels.

b) Subfield labels for the horizontal components of spatial address fields shall be "X" and "Y".

c) The first part of the file title shall be consistent for all files within the transfer, but the last part should be unique for each file and give some indication of the contents of that file. This file title should be equivalent to the eight character base name (plus the optional ninth character).

6.8 Use of Binary Data Type for Spatial Addresses

A binary data type shall be used in the subfields of a spatial address field. The binary subfields shall be a fixed width of 32 bits.

a) In the case where all DRs in a DDF contain the same number of repetitions, a user-calculated repeat factor shall be used in the format control for the field. A format control for a spatial address type field shall have the form:

(n(2B(32)))

where n = the number of spatial address tuples
2 = number of dimensions (x,y) allowed by SRPBE
B = indicates binary type subfield
32 = specifies the width of the binary subfield

b) In the case where each DR in a DDF contains a different number of repetitions, the following format control shall be used:

((2B(32)))

where 2 = number of dimensions (x,y) allowed by SRPBE
B = indicates binary type subfield
32 = specifies the width of the binary subfield

ISO 8211 does not permit a binary field located after the left parenthesis to implicitly repeat. Therefore, the above format includes an additional pair of parentheses.

6.9 Use of Character Data Type for Dates

(see also SDTS Part 3, Section 9.2, Dates)

Dates in the form YYYYMMDD are to be encoded as ISO 8211 data type = A.

6.10 README File

(see also SDTS Part 3, Section 11, Conformance)

The README file shall contain:

a) volume name;

b) date;

c) information about the SDTS transfer(s) which includes but is not limited to the following:

1. a list of subdirectories and non-SDTS files, as appropriate;
2. the file name of the Catalog/Directory module;
3. the Catalog/Directory location;
4. an explanation that this file and all other SDTS files are in ISO 8211 format;
5. an explanation that the Catalog/Directory module carries a complete directory of all other SDTS ISO 8211 files comprising the SDTS transfer;
6. notes about any non-SDTS adjunct/auxiliary files;
7. a brief explanation of the spatial domain;
8. purpose;
9. authority (e.g., FIPS PUB 173, this profile, other standards used);
10. source (e.g. agency name);

11. contacts within the source organization;

12. description of any issues about the transfer, special purposes (i.e. private agreement transfer) or non-standard uses of modules, etc.

ANNEX A: SDTS BIIF EXTENSION

(Normative)

This annex contains an option which permits the use of the Basic Image Interchange Format (BIIF) as an adjunct file.

BIIF is a standard developed to provide a foundation for interoperability in the interchange of imagery and imagery-related data among applications. SRPBE provides a specification of the valid data and format for all fields allowed under SRPBE.

1.1 Dependency on NITF BIIF Profile

The SRPBE ANNEX A defines only the specific distinctions required by the SDTS/BIIF geospatial raster image community that are not already established by the NITF profile to BIIF Model Profile. Unless otherwise noted the NITF profile to BIIF is included by reference. The NITF profile to BIIF is based on Military Standard 2500B, National Imagery Transmission Format which is available from the National Imagery and Mapping Agency http//:www.nima.mil, at NTB (NITF Technical Board) under the organization directory. The requirements for SDTS are akin to the NITF requirements or enhancements to the SDTS Profile are provided by the BIIF Extension.

SRPBE constraints on NITF profile to BIIF			
FIELD	**TYPE**	**CE / SIZE**	**SDTS Profile Option**
OSTAID (File Header)	R	A/10	SDTS prefix in first four characters (TBD with NITF Tech Board, optionally create tag to point to SDTS CATD Module for file names)
OID (File Header)	R	A/45	SDTS previous in first four characters (TBD with NITF Tech Board optionally create tag to point to SDTS CATD Module for file names)

1.2 Extension and Tags

Certain Tagged Record Extensions (TRE) and SDEs have been defined by other NITF data producers. A data encoder can find information on available TRE from the central registry at the Joint Interoperability Test Command in Fort Huachuca, Arizona (www.disa.itsi.gov).

The following NITF tags are required to be supported by BIIF decoders (TBD):

Mosaic Tag - when a transmission carries multiple images which overlap

History Tag - Lineage information (these tags should also include FGDC requirements)

Elevation Tag - carrying elevation grid as ancillary data to an image

FGDC tags - Lineage information

If georeferencing information in the SDTS file is sufficient and Annex A is not being used, the BIIF tags are not allowed. When a BIIF file is used to transfer georeferenced data, the BIIF Geospatial Support Data Extension tags are defined in the NSIF profile to BIIF, annex D and are required by SRPBE. The georeferencing data may be duplicated in both SDTS files and BIIF files.

ANNEX B: COLOR INDEX MODULE OPTION

(Normative Annex)

This annex contains an option which permits the use of the SDTS Color Index Module (See to SDTS Part 1, Section 5.8.5, Color Index) to carry color table information for raster data. The SDTS Color Module shall only be used to describe color information for raster data in native SDTS structures.

The Color Index module is used to transfer color palettes. A color palette's (color table) data values for red, green, blue and/or black, are converted to the corresponding red, green, blue, and/or black component subfields of the color index module. Data values are real numbers normalized between 0.0 and 1.0. The number of significant digits is decided by the encoder. If a data encoder needs more color model options, see BIIF color options (Clause 4.2.4.2.2 Colour Lookup Tables).

BIIF Note: If BIIF is used to encode an image, then use the BIIF color mechanism to encode color information. BIIF Clause 4.2.4.2 Grayscale and Color Lookup Tables includes additional capabilities for encoding color using the mechanisms in BIIF.

1.1 Color Index Module Names

Multiple Color Index modules could be transferred with this specification. One Color Index modules corresponds to one color palette. If one color palette is transferred, and therefore, one Color Index module, then the Color index module name will be CLRX. If two or more color palettes are transferred, the first module name and primary field name shall be CLR0. The second module name and primary field name shall be CLR1. This pattern shall continue through CLR9. Once the module names CLR0 and CLR9 are used, the names shall continue through CLRA, CLRB, CLRC, etc... to CLRZ.

1.2 Module Restrictions/Requirements: Identification Module

To indicate that this annex is being used, the Profile Identification subfield shall include the annex letter preceded with a slash "/".

ANNEX C: COMPRESSED RASTER OPTION

(normative)

This annex contains an option which permits the transfer of compressed raster data. Compression algorithms other than those identified in SDTS and the NITF profile to BIIF are not allowed.

SRPBE is limited to compression of raster data because compression of the overall file is not within the scope of BIIF or SDTS. Compression algorithms included in SDTS Part 1 (that is, Run Length Encoding (RLE) and Huffman Encoding) are allowed by SRPBE. However, if data is being transferred in accordance with present or future annex(s), restrictions specified in the subject annex (s) shall take precedence.

The SRPBE requires support of decompression for SDTS RLE, SDTS Huffman, and JPEG.

In SDTS, compression is specified at the raster object level. That is, all layers of a single raster object are compressed as a whole or uncompressed. This annex permits each raster object to specify compression independent of other raster objects in the same transfer.

Lossless compression methods should be used on gridded data.

BIIF Note: Compression algorithms permitted in BIIF include Vector Quantization (VQ) and JPEG (both lossless and lossy), Bi-level (Bi-tonal). Use of other compression schemes is included by the NITF profile to BIIF. When using BIIF encoding, the SDTS defined compression schemes are not permitted, unless specifically included by the

NITF profile to BIIF. The NITF profile to BIIF requires decompression of VQ, Bi-level, JPEG (lossy and lossless) and compression using JPEG. Compression using VQ and/or Bi-level are optional under Annex A.

1.1 Module Restrictions/Requirements: Identification Module

To indicate that this annex is being used, the Profile Identification subfield shall include the annex letter preceded with a slash "/".

ANNEX D: SPECIAL PURPOSE TRANSFERS

(Normative)

Image is optional - A transfer may contain metadata only, as long as the relationship to a prior image transmission is unambiguous.

Rapid Data Transmission (as an example case)

For use when rapid transmission is critical or when bandwidth is very limited. This profile annex option is included to satisfy the needs of data encoders for cases of time critical spatial data transmissions, and other special purposes.

SDTS is primarily intended to be used for self-describing transfers, which are more appropriate for blind transfers and archives. Rapid transmission defines a scenario that identifies the need to provide imagery data in near real-time for field employment (includes battlefields, fires, floods, etc.) The following table provides a comparison of characteristics to assist in determining the appropriate transmission option.

Transmission Comparison	
Blind transfer/Archive Characteristics	Rapid Transmission Characteristics
Data of Historical Significance ("long term value") usually	Data expires rapidly
Sender Known, Receiver Unknown: Send maximum information (self-contained transfer)	Sender Known, Receiver Known: Send minimal information because context is pre-established
One-way Communication	One-way Communication
Data Assessment /Interpretation/Analysis done afterwards	Data Assessment /Interpretation/Analysis done beforehand
Blind/Broadcast (open) -Public FTP, Sales Counter	Point-to-Point/Broadcast (secure)

This profile annex relaxes metadata content requirements when the data transfer situation requires rapid transmission and can be used with either SDTS-formatted image data (core of this profile) or with BIIF-formatted image data (Annex A of this profile.)

Rapid transmission always involves communication from a known sender to a known receiver. In this situation much of the metadata that would normally be required is unnecessary because it can be correctly assumed or implied. The format, data fields, spatial objects from SDTS and/or BIIF are valid in this situation, i.e. there is no reason it won't work. However, a dataset that has been sent with abbreviated content is not something that would get archived or kept for later use.

In the case of a special purpose transfer, certain mandatory SDTS metadata requirements become optional. They are:

a) SDTS Quality Report (SDTS requirement)

b) SDTS Data Dictionary (SDTS requirement)

c) SDTS External and Internal Spatial Reference Module

1.1 Module Restrictions/Requirements: Identification Module

To indicate that this annex is being used, the Profile Identification subfield shall include the annex letter preceded with a slash "/".

ANNEX E: EXAMPLE OF BIIF ENCODING

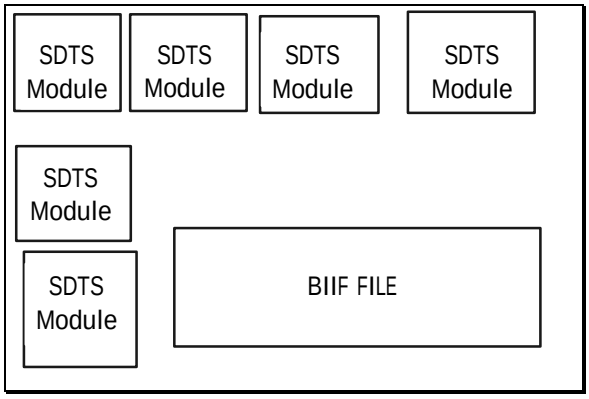
(Informative Annex)

This annex to the SDTS Raster Profile with BIIF Extensions (SRPBE) serves to facilitate the use of the SRPBE by providing diagrammatic illustrations of SDTS, BIIF, and the relationships intended by SRPBE. Examples of BIIF encoding are also provided (TBR).

Example diagrams showing SDTS and BIIF used together in accordance with Annex A, will be inserted here. Examples provided show the following cases. (TBR)

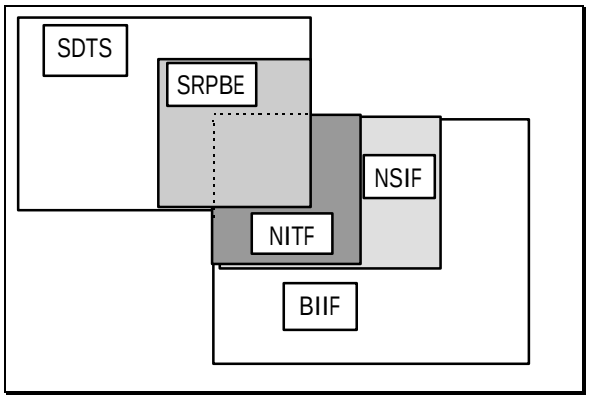
- o case: metadata (FGDC like, history tags?) in SDTS and image in BIIF (see BIIF training materials)
- o case: SDTS DEM with DOQ in BIIF

SDTS is a modular structure composed of conceptually related sets of information. BIIF is a fixed field file structure, that is extensible by tagged record extensions.



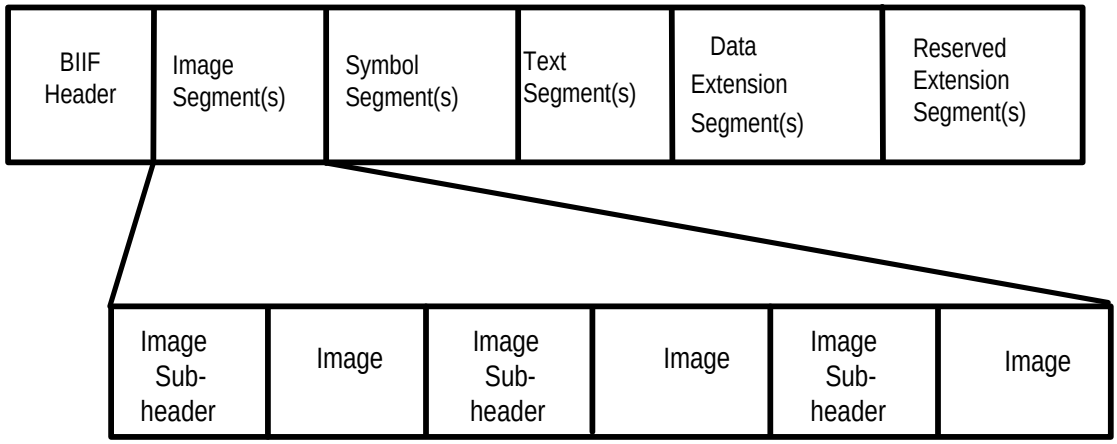
Basic File structures of SDTS and BIIF

The SRPBE is fundamentally comprised of SDTS, and optionally includes BIIF extensions (delineated by the overlap of SRPBE and NITF/NSIF profile to BIIF.



Conceptual delineation of SRPBE

The BIIF Header File Construct has sequential segments of data types initialized by a formatted header.



NITF header structure

The following diagram depicts a simple BIIF construct consisting of a single layer example , no symbols, labels, etc., only image (TBR).

HEADER	IMAGE SUBHEADER	IMAGE DATA	DATA EXTENSION SUBHEADER	DATA EXTENSION

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	MAIN HEADER																	IMAGE SUBHEADER							DES SUBHEADER					
FIELD NAME	FHDR	ETC	FL	HL	NUMI	LISH001	LI001	NUMS	NUMX	NUMT	NUMDES	LDSH001	LD001	NUMRES	UDHDL	XHDL		IM	ETC	UDIDL	IXSHDL	IXSOFL	IXSHD	IMAGE DATA		DE	DESTAG	ETC	DESOFLW	DESITEM	DESSHL	DESDATA
BYTES	9		1	6	3	6	10	3	3	3	3	4	9	3	5	5		2		5	5	3	5			2	25		6	3	4	4000
FIELD VALUE	BFMP01		00008050757 64	000417	001	0984442	00846934656	000	000	000	001	0249	000042000	000	00000	00000		IM		00000	980003	001	TAG123			DE	TRE_OVERFLOW		UDID	001	0000	
												TAG 1 (32,000 BYTES)						TAG 2 (27,000 BYTES)				TAG 3 (39,000 BYTES)							TAG 4 (42,000 BYTES)		

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Annex F: BIIF to SDTS Crosswalk

(Informative)

This annex to the SDTS Raster Profile with BIIF Extensions (SRPBE) compares and contrast terminology used in the Basic Image Interchange Format (BIIF) part of SRPBE and the SDTS Raster Profile. This table is intended to identify terms not to be used interchangeably by the standards, and more importantly, common concepts termed differently. Attempts have been made in the SRPBE to be sensitive to the high potential for confusion and efforts to dispel that confusion include this annex. Refer to glossary in Section 1 of this document for definitions of each term.

SDTS and BIIF Term Crosswalk

SDTS term	BIIF term
transfer - composed of modules and adjunct files	data segments file - a file is composed of one or more data segments . Defined segments contain specified types of data. Within the SDTS Raster Profile - the BIIF file(s) is part of the SDTS Transfer
adjunct file - Within the SDTS Raster Profile, the BIIF file(s) are defined as adjunct files. This is restricted to be image data.	file - Within BIIF, restrictions on content are not applied.
module - Within the SDTS Raster Profile, this is an ISO 8211 file.	no equivalent
field - set of subfields	conditional fields - when in sets of BIIF fields
subfield - contains the data	field - contains the data
	repeating fields (identified by a field that specifies the number found in the file) and may be found as a group. When no valid data is available, the bytes are blank filled.
mandatory subfield - data or spaces	required fields - data or spaces
User defined subfields are allowed only in the SDTS Attribute Modules.	tag - BIIF mechanism for unique user defined elements.
No equivalent at this time.	data extension segment - BIIF mechanism for encapsulated data, i.e. RPF. Could be stand alone

	data.
Profile - subset of a base standard.	Profile - subset of a base standard.
No equivalent	Compliance Level - system certification based on ability to pack and /or unpack various compression levels.
Identification Module - Contains Conformance Level field and includes standard identification and profile.	BIIF File header fields - identify the profile, version and standard.
Layer - two-dimensional array of values associated with a grid or image.	
Layer - image related	Band - one of the two-dimensional (row/column) pixel value arrays that comprise an image. In the case of 24-bit true color images, the representation is three two-dimensional arrays (RGB).
Pixel - The smallest non-divisible picture element.	Pixel - The smallest non-divisible picture element.
Grid Cell - The smallest data element in an array of gridded data.	
Tile - equivalent	Block - equivalent

NITF format requirements on Lineage

NITF/BIIF field	NITF/BIIF Location	SDTS value	FGDC Field
OID - Originator Id	File Header		Point of Contact 1.9
FDT - File date	File Header		
ISORCE - Image source	Image Subheader	comparable to SDTS (FGDC) Source Materials	Source Information 2.5.1
IDATIM - Image Date and Time	Image Subheader	dates	Time period of content 1.3
History Tag			Process Steps 2.5.2